COMPARISON OF DEER CENSUS TECHNIQUES APPLIED TO A KNOWN POPULATION IN A GEORGIA ENCLOSURE[1]

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Much work has been done to develop better techniques for censusing deer, but few chances have been available to compare population estimates or indices with known populations. Such an opportunity was presented by the 746-acre Marine Corps Supply Center enclosure at Albany, Georgia. The enclosure was stocked in 1959 and 1960 with 27 white-tailed deer *(Odocoileus virginianus)*, maintained at a fairly constant level through hunting, and finally in 1963, completely killed out so that the composition of the herd could be reconstructed for each year of the study. This paper reports the accuracy with which five techniques—pellet group counts, track count, drive censuses, strip counts, and hunter observations—estimated the true population or detected changes.

The study area has been described in detail by Johnson and Downing (1962). Briefly, it is fairly typical of the flat to rolling upper coastal plain of southwest Georgia. Much of the area is old abandoned fields and cutover pinelands. However, two swamps, several intermittent wet areas, many old fence rows, and a creek bottom are wooded. Deer herd levels ranged from 32 in 1960 to 16 in 1963. The deer were securely contained behind a nine-foot fence.

PROCEDURES AND RESULTS

Pellet Group Count: One hundred 1/50-acre circular pellet group count plots were randomly located and stratified proportionally among the four forest types. Several counts at different seasons of the year estimated the population to be less than 25 percent of its actual size (based on McCain's (1948) and Eberhardt and Van Etten's (1956) defecation rate of 12.7 groups per deer per day). Investigations with marked pellets indicated that dung beetles were destroying pellets quite rapidly, especially fresh ones. Since no suitable repellent was available, the insecticides heptachlor, chlordane, endrin, sevin, and DDT were applied to 100 additional plots located adjacent to the original plots. Ten groups of moderately fresh deer pellets were systematically placed in each plot, 100 of which were treated and 100 untreated as the control. Heptachlor and chlordane appeared to reduce losses to dung beetles approximately 70 percent.

Because there was some question whether the pellets used were fresh enough, it was decided to apply the most effective of these insecticides, heptachlor, to one-half of 200 new plots established within two 60-acre areas known to be heavily used by deer to see if the insecticide would protect naturally deposited pellets. After 52 days a count was made which revealed more pellet groups in treated than in untreated plots, yet treated plots estimated the population at only 20 percent of its actual size. These counts were therefore abandoned and their use will not be continued until a more effective dung beetle deterrent is found. It would seem advisable for such a deterrent to be nearly 100 percent effective. Otherwise, different population levels of dung beetles will have different effects. It is also imperative that the deterrent does not affect deer.

Track Counts: Most workers count tracks along roads and firelines. Tyson's (1959) work in Florida indicated a nearly 1:1 relationship between deer crossings of a mile strip and the number of deer inhabiting the adjacent square mile. We could not use a similar design because

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the enclosure was less than a mile wide at its widest point. Moreover, it was felt that randomly chosen smaller strips would be preferable because roads usually traverse the higher, drier sites. For this reason a 10- by 10-foot cleared plot was established in 1960 near each of the original pellet group plots. More than 40 times during the study, these plots were raked clear of tracks and tallied 24 hours later. In 1962 the number of plots was increased to 200 by adding a 4- by 25-foot plot at each location. Tallies were made for 83 days (less rainy periods) from June to September 1962 and for eight days in October 1962. Consecutive tallies were made to study the effects of weather, including temperature, relative humidity, the temperature-humidity index (discomfort factor), rain, wind, cloud cover, and barometric pressure. Considerable day-to-day variation was noted, however, that could not be correlated with weather changes (table 1). Furthermore, there was little daily correlation during the summer of 1962 between the two sets of 100 plots (considered as separate, superimposed sampling systems), suggesting variation from inadequate sampling rather than environmental factors. Our data indicate that 12 July or August counts of 200 plots or 10 October counts of 100 plots, involving some 300 deer crossings, would be required to detect a 20 percent difference in deer movement (and probably deer populations) 95 percent of the time.

Table 1. — Means and standard deviations of track counts conducted in the Albany, Georgia, enclosure, 1960-1962.

Dates	Plots	Actual deer population	Days counted	Mean daily crossings	Standard deviation
	— — — — — — Number — — — — — — —				
Oct. 1960	100	32	4	40.5	9.2
Oct. 1961	100	32	17	33.8	11.3
Oct. 1962	100	28	8	25.9	6.5
Oct. 1962	200	28	8	64.0	8.6
Jan. 1961	100	19	7	23.9	12.3
June 1962	200	18*	17	37.4	18.3
July 1962	200	18*	23	27.0	8.1
Aug.-Sept. 1962	200	18*	30	20.5	7.8

*Adults only.

The ratio of fawn to adult crossings is apparently a poor measure of the fawn/adult ratio. During the 18 counts from August 17 to September 3, 1962, when fawns should have been active and their tracks distinguishable from adults, 33 percent of plot crossings were made by fawns; the population was actually 41 percent fawns, a highly significant difference (computed chi-square=14.01, 1 d.f.).

We were interested in the seemingly high number of plot crossings in relation to the small percentage of the area occupied by plots. We made involved calculations which assume that the likelihood of a deer crossing a plot during random movement is in proportion to the average "intercepting" width of the plot. By this we mean the width perpendicular to a deer's travel, averaged for all the points of the compass. In this study there were two shapes of plots, 10-by-10-foot with an average intercepting width of 12.4 feet, and 4- by 25 with an average intercepting width of 18.7 feet. There was one of each type of plot per 7.46 acres. In order to cross a 10- by 10 plot a deer must walk, on the average, five miles (which may be considered as a strip 12.4 feet wide, sufficient to equal 7.46 acres). We have computed the average number of miles of such strips each deer would have to walk each day to equal the number of plot crossings observed (table 2). We made similar calculations from Tyson's *(op. cit.)* data, which indicate that only one-half as many miles were walked per day as in this study (1.9 to 2.1 miles per day in Florida as opposed to 3.2 to 4.4 miles in Georgia). In these calculations the average intercepting width of each of Tyson's plots (a mile of road) was considered to be approximately 3,300 feet. We feel these assumptions are valid, but cannot fully explain why our deer appeared to walk twice as far as Tyson's. Deer may be somehow attracted to our plots or tend to follow the observer's well worn trail to the plots, or both. As a result, the movement indicated may be greater than that actually occurring.

Table 2. — Average daily walking distance per deer indicated by crossings of track plots, Albany, Georgia, enclosure, 1962.

	10- by 10-foot plots	4- by 25-foot plots
	— — — — Miles	— — — —
Summer 1962	3.2	4.0
October 1962	4.4	4.3

Drive Censuses: One or more drive censuses of the enclosure were made annually from 1961 through 1963. The first census was conducted during daylight with 140 drivers. Subsequent drives were made at night with 11 to 47 drivers using headlights (table 3). Night driving requires fewer personnel and makes organization much easier. All drives were carefully controlled by means of a system of grid stakes. The first two drives made use of a 500-foot grid with seven lines of stakes lengthwise of the enclosure. The 500-foot grid was subsequently replaced with a 330-foot grid having 11 lines. One additional guideline between each staked line was marked with reflectors thumb-tacked to trees.

The single daylight drive was very accurate, but was not repeated because of the number of personnel needed and inherent difficulties of organization and control. Most drives were sufficiently accurate to detect 20 percent changes in the population. Night drives have doubtful application in areas not surrounded by fence, however, because of the number of "counters" required to observe deer leaving the driven area. More counters would be required at night due to the limited range of headlights. Tyson (1959) counted tracks of deer leaving the driven area on strips surrounding the area. Track counting at night, however, is very difficult.

Table 3. — Drive censuses of Marine Corps Supply Center enclosure, Albany, Georgia, 1961-1963.

Dates	Drivers	Driver spacing	Deer counted	Deer present	Weather
	Number	Feet	— — Number	— —	
Jan. 1961	140	30.0	18	19	Cold dry day
Apr. 1961	15	250.0	17	21	Rainy night
Dec. 1961	11	330.0	23	32	Rainy night
Dec. 1961	22	165.0	33	32	Rainy night
Dec. 1962	47	82.5	36	28	Rainy night
Dec. 1963	34	110.0	19	16	Dry night
Dec. 1963	23	165.0	14	16	Dry night

Strip Counts: An attempt was made to adapt the strip count (Hayne 1949) to conditions within the enclosure. After walking 10 to 15 miles of lines, with random starting and ending points, it became apparent that the number of man-hours required to observe an adequate number of deer was impracticably large. More than two miles of walking were required to see one deer because of short flushing distances. A similar number of lines walked at night did not show an appreciable increase in number of deer seen. Use of this technique was therefore abandoned as being impracticable under the cover and population conditions prevailing.

Hunter Observations: Reconstruction of herd size has made possible an appraisal of hunter sightings of deer as a possible index to deer numbers. Each December, beginning in 1960, two days each of light hunting pressure (four hunters), medium pressure (eight hunters), and heavy pressure (12 hunters) were conducted. Archery hunting was also conducted, but no attempt was made to keep numbers of hunters uniform. Each hunter was required to report how many deer he saw while sitting and while walking, and how many hours he spent at each type of hunting. During 1964, hunters also prepared maps of each day's walking activity. The 1964 hunts are included because the area had recently been restocked with a known number of deer (40 adults plus offspring).

Population size, number of hunters, day of the hunt, and weather conditions do not appreciably affect the percentage of the population seen per hour. Only the method of hunting has much effect. There was considerable variation in the data (table 4), probably because of the small number of hunters used each day. However, our data indicate that five 48 man-day samples may be sufficient to detect a 20 percent change in the population 95 percent of the time.

Table 4. — Standard deviation of means,* gun-hunter observations, Albany, Georgia, enclosure, 1960-1964.

	Man-hours hunted	Deer seen	Population seen per hour	Standard deviation of mean
	— — Number	— —	Per cent	
Sitting	692	162	.88	.75
Walking	1,240	552	1.95	.97
Overall	1,932	714	1.56	.69

*Computed on the daily means of 30 days of 4-, 8-, and 12-man hunts.

Users of this technique should be cautioned against using the "overall" deer-per-hour figure unless there is reason to believe that the ratio of sitting to walking is unchanged from sample to sample. In our studies, for instance, archers could not be compared with gunners "overall" because gunners walked 64 percent of the time, whereas archers walked only 29 percent of the time. Hunters see more than twice as many deer per hour of walking as they see per hour of sitting.

It would also seem inadvisable to compare hunter observations on two different areas. Hunters in the Cusino, Michigan, enclosure, for example (Van Etten, Switzenberg, and Eberhardt, 1965), saw 2.93 percent of the population per hour (our calculations), compared to 1.56 percent (overall) in our study. These areas are similar in size and herd density, but differ in visibility and cover conditions. Hunting methods were considerably different as well.

Additional research may show that deer seen per mile walked may have a closer relationship to population than deer seen per hour hunted. This type of data was collected only during 1964 and results are inconclusive. Our hunters walked slightly less than one mile per hour and 1.2 miles per deer seen. Such counts may be similar to the strip count. In areas less well known to hunters and with fewer distinctive features, however, the problem of accurately mapping hunter travels may be insurmountable.

Hunter observations are apparently not reliable indicators of sex ratio. Hunters identified 21.5 percent of the deer they saw as antlered bucks, whereas the herd contained 28.9 percent, on the average. This was a highly significant difference (chi-square=36.90, 1 d.f.). In the Cusino, Michigan, enclosure (Van Etten, Switzenberg, and Eberhardt, *op. cit.*), hunters identified only 7.5 percent of the deer as antlered bucks, whereas the herd contained 19.5 percent (our calculations). Antlered bucks were easy to identify in the Georgia enclosure because nearly all had forked antlers, and tended to hide in dense ground cover until closely approached by the hunter.

Conclusions: With the exception of the pellet group count, all the techniques investigated during this study appear to be workable. Sample size requirements, however, make the strip count, and on many areas the track count, impracticable. The drive census is only adaptable to small areas, preferably surrounded by dirt roads or firelines. Hunter observations appear to be an excellent index, but only if the same area is compared year to year. Sex ratios observed by hunters are not useable directly, but may indicate differences between years. The hunter observation index is by far the cheapest technique used during this study and is readily adaptable to the check-in, check-out type of hunt held in many southeastern states. The technique has an additional advantage in that it gives the hunter a feeling of "participation" which may be helpful to his acceptance of deer management programs. We offer the hunter observation index as cheap and easy, but inherently variable. The technique is limited in its accuracy, but probably no more so than many other conventional techniques. Where greater accuracy is required, we recommend an entirely new approach. We cannot suggest what direction the new approach should take, but feel that an attempt to further refine any technique affected by the variability of weather or deer movement is a waste of time and money.

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SOME SPECULATIONS ON THE MINIMUM HABITAT REQUIREMENTS OF BOBWHITE QUAIL

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ABSTRACT

This paper reports on a review of 24 selected publications dealing with the habitat requirements of the bobwhite quail *(Colinus virginianus)*. Its purpose is to bring the results of these investigations into sharper focus in an effort to determine the minimum number of vegetative types, and the minimum amount of each, that are needed to support a single covey the year round. It also seeks to stimulate further inquiry into the validity of the hypothesis presented. The literature reviewed indicates that quail ordinarily require at least three vegetative types—crop fields, brushy cover, and grassland. A further requirement of quail range is that these vegetative types be well interspersed so some of each is available to each covey. The winter food requirements of a covey of 12 birds can probably be met by three-fourths of an acre of annual food plants or one-seventh of an acre of bicolor (*Lespedeza bicolor*). The presence or absence of a "headquarters" area of brushy cover may be the determining factor in deciding the habitability of a covey range. A minimum of 450 square feet of this brushy cover appears to be needed. At least one-fifth of an acre of grassland, primarily for nesting cover, is needed. It is suggested that a hypothetical covey range might consist of the above amounts of vegetation concentrated in a rectangular field 99 feet wide and 484 feet long when the annual food patch is used, and a rectangular field 39 feet wide and 454 feet long when bicolor is used for food. The habitability of such a covey range may be modified by population density,